SCIENCE

VOL. 88 FRIDAY, SEPTEMBER 23, 1938 No. 2282

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE CHANGING VALUES OF SCIENCE[1]

By Dr. R. C. WALLACE

PRINCIPAL OF QUEEN'S UNIVERSITY, KINGSTON, ONTARIO

THERE is no need to elaborate the assertion that changes of emphasis are taking place in our time in the values of science. This has been a matter of perception and of observation. Men whose responsibility it is to make contributions to the advancement of their own fields of science have felt the change. Others who are not scientists have spoken about it, and have not infrequently misunderstood its meaning. It is a formidable task to endeavor to interpret the changes which are taking place, more particularly because we are in the middle of the current. We have not a position of objective independence. But it is of value to the speaker at least, whose day-by-day thinking is perforce confined to the field of educational values, to clarify in his own mind the shift in emphasis and in meaning which science, as a tool of thought, is experiencing before our eyes. It may not be out of place to take the occasion of the Hector Maiben lecture, which you have honored me with the invitation to deliver, for the presentation of such thought on this subject as I may be able to place in coherent sequence.

It is, after all, somewhat of a paradox that there should be any change of attitude in the scientific way of thinking. So much of the contribution of science in the last three centuries is a permanent readjustment of the thought of mankind and is not subject to change. The rationalism of the scholastics of the middle ages gave way under the revolt of the Renaissance, and the growing demand for facing facts. It was this demand which led to the development of modern science, and to its great victories in the exploration of nature and the harnessing of her forces for the use of man. When he finished his treatise on the "Principles of Psychol-

[1] The Maiben Lecture delivered at the meeting of the American Association for the Advancement of Science, Ottawa, June 30, 1938.

ogy," William James wrote, "I herewith forge every sentence in the teeth of irreducible and stubborn facts." James's was the scientific method. Since the time of Roger Bacon, the scientist has forged every sentence in the book of exploration "in the teeth of irreducible and stubborn facts." He has persuaded the world to adopt the same method in all departments of knowledge, no matter whether related to science or not. The historian, the sociologist, the psychologist, the theologian wrestle with stubborn and irreducible facts because the scientist has shown in his field of work that they must be faced and accounted for. There has grown up an attitude of intellectual honesty which has had a cathartic value in clearing away the unrealities which had worked themselves into the rationalism of the pre-Renaissance period.

Further, there has developed under the hand of the scientist a technique of obtaining the pertinent facts. Facts do not come of themselves. They must be sought for under controlled conditions, or under conditions which, if not controllable, are fully understood. The experimental sciences have provided the means wherewith to ascertain facts under controlled conditions. They have had their special sphere in the physical realm; but the biologist has used the experiment with amazing success in the less easily controllable field in which he operates. In the sciences which deal with man, and in social studies of all kinds, the experiment is less readily applicable, and the student is forced back on the study of the conditions under which the data accumulate. These conditions may be unplanned, but they must be known. The scientist has shown how to disentangle the significant conditions from the adventitious. He has placed facts in their setting in the flow of events.

In this whole process an intellectual habit has been created. Through the path of science we may not yet have traveled far in answer to the quest of the "why," but we have gone very far in satisfying the question as to the "how." We have acquired the habit of mind—and it has become almost intuitive—of finding out under what conditions this or that thing takes place. We assume an orderly process in nature; and we determine the order in each particular circumstance. Within the limits in which scientists work, the assumptions have been justified in a practical way by the results. Science has acquired a prestige in the modern world, not so much from its intellectual attitude, but because of the contributions which the scientist has made to the amenities of living. In the things that we eat and drink, in the clothing wherewith we cover ourselves, in our communication and our traveling, in our amusements and our recreations, we lean on the scientist at every turn. He has become indispensable. In his understanding of nature's laws and in his using of the knowledge to the satisfying of the needs and the desires of man, he has shown results which convince. He has become respectable and even respected. A practical age demands a sign which it can understand. That sign has been given with convincing iteration.

It seemed in the nature of the case inevitable that the new tool and the new method of science should give rise to a mechanistic conception of nature's processes, whether in the inanimate or in the animate sphere. Under similar conditions, similar phenomena occurred. The physicist would be prepared to go even further, for his is, from the experimental side, the most exact of the sciences. His formulation would be: Under the same conditions, the same phenomena occur. Precisely the same conditions do not occur; nor can they be made to occur by even the most skilful experimenter. But the basic conception of the uniformity of nature's processes has served the scientist so well as a working philosophy that it has been taken to be, to all intents and purposes, a fundamental truth. Without it, all experiments would cease; for results could have no meaning. And it was of purely philosophic interest whether certain conditions caused certain phenomena to occur, or whether, as Hume would have it, the relationship is simply that of time sequence. To the scientist it was enough that he could count on the sequence, and it was simpler to use the phraseology of cause and effect. Such a system, closed and complete, works as a machine. There may be an awkward question as to the winding up at the beginning; and there have been the prophets who foresee an eventual running down to a dead stop; but for our time it goes, and goes inevitably by the force within itself. Not only in the physical world is this the case. The biological processes are physical and chemical; even the mental processes in man himself have a physical and chemical background. It has seemed logical, therefore, to many biologists and psychologists that the mechanism of the physical world operates with the same rigidity and inevitability in the living processes and in man himself. The behaviorists are the legitimate offspring of the mechanists. And if in the social relationships the operation of the mechanical principle has not yet been so clearly established as in inanimate nature, there has been the feeling that this is only because the factors are less easily analyzed, and that with the development of the social sciences the principle will be found to operate with the inevitability which is displayed elsewhere. The work of classification and analysis goes on. The statistician accumulates data in the field of sociology. Measurement has invaded the preserves of the educationist. There is no realm so intangible that the scientific tool may not find a hard surface on which to operate. There is no human problem so complex, as many think, that it may not ultimately resolve itself

into the ordinary phenomena of causal conditions within the system, and the inevitable consequences of those conditions—in a word, a system working within itself in a mechanical process as rigid and unalterable as the movements of a clock under the force of its mainspring.

And yet, we have somehow felt not quite satisfied. The authority of science has been too convincing for complete conviction. It has overreached itself, and is in danger of falling on the other side. Good men suffer not infrequently from the excess of their virtues. Their goodness is too overpowering to be altogether real. In similar fashion, the underlying assumptions of the scientific method have been too complete to meet the case. They have left no room for anything else, and there is something else which the methods of science fail to elucidate. That is the reason for the reorientation and revaluation which is taking place to-day. In this readjustment the scientists are joining hands with the philosophers; for the task belongs not to science, nor to philosophy, but to science and philosophy together.

Overemphasis is something to which the mind is prone; and it is, to our way of thinking, a question of overemphasis with which we are dealing in the development and use of the scientific tool. We have been passing through a period of depression, which has given special significance to the dependence of man on his economic setting. If we were to judge from the discussions and the literature of the past eight years, we would be led to the conclusion that man is primarily concerned about, and influenced by, his economic relationships. We would be led to subscribe to the premises on which Marx erected his political philosophy. And yet we know that this is not the truth of the case. There are other, and more fundamental, springs of life and conduct than the economic. We have been under the spell of the overemphasis of a phase of the truth; and we are only gradually coming back to a sounder balance. So in the changing emphasis in the religious life, where in one age the dogmatic formulation is all-important, in another the social gospel prevails, in another the mystical approach. It seems difficult—indeed it may not be possible—to maintain through the ages an even balance. Truth seems to unfold itself by exposing the falsity of the over-statement of positions, which, within their own limits, are true.

There is a growing doubt as to the applicability of the scientific method in the study of human affairs, to the extent at least to which it has been used in the last quarter of a century. It is this doubt, as much as the recent discoveries in subatomic physics, which has raised the question that is before us this evening. It goes without saying that there is a great body of facts which can be accumulated, tested, analyzed, tabulated. These facts clarify situations otherwise vague, about which opinions are accustomed to be formed without the support of the necessary data. This process is essential; and only the trained scientist can do this work. But those among us who have to deal with some of the mental and emotional expressions of human activity have not felt assured. To take, for example, the field of education. Much has been done, and some of it of real value, in analyzing objectives and aptitudes and the specific values of this or that educational tool in developing the aptitudes which are needed for the various professions or vocations. In these investigations the scientific method and technique have been employed. The work has clarified the situation. It has given a sense of precision to an otherwise somewhat nebulous subject. But one is left with the feeling that there are values in education—and these the most important—that elude the pan of the balance. They are imponderable, but they are very real. Any one who has come under the influence of an inspiring teacher knows the things whereof I speak. They are the things which are felt, not said; and they are of the very essence of a liberal education. They are far beyond the power of analysis of the scientist, but they are understood by the scientist as a man. So too, for instance, in the progress of the study of sociology. Very much of real value has been accomplished by the detailed statistical studies which have been made in recent years. We understand better, and in a quantitative way, how people are affected in the mass by opinions and movements and habits. We are thrown back, however, on the fact that while in a general way mass movements may appear to be reduced to a quantitative basis, the individual unit is a human being of unpredictable responses and reactions; and there are values in sociology as in education which elude the precision methods of the scientist. In economics, too, the conviction grows on the layman that the discrepancies between theory and fact which have been in evidence in recent years are to be explained by the consideration that economic laws work not *in vacuo* but in and through human beings, who refuse to be treated as though they were robots working under purely mechanical forces.

Is it the case that the difficulty lies, not in the incompetence of science in this field of human affairs, but in the lack of knowledge of the complicated factors which operate in human life and thinking and conduct? Is there not so much to be explored before we can say so peremptorily that there are areas beyond the limit of scientific analysis? Will not the rapidly advancing knowledge of psychological processes change the situation? Can the scientist go forward at all unless on the hypothesis that the scientific method is applicable?

Or, on the other hand, are there values which are beyond the reach of the scientist *qua* scientist, and of which his method has no means of assessing the validity? This is the fundamental question; and we have discussed the human problem first because the question has arisen in many minds in recent years. There are scientists not a few who feel that as scientists they must go forward on the assumption that there are open fields still to be cultivated, but as men feel that there are regions, the door to which they will not be able to unlock by the key which science provides.

We shall return to this question. But what is the situation in the inorganic world, where the problems of life, ever more complicated as we ascend to the level of man, do not confuse the issue? Are there limitations here as well which have to be understood and defined; and what is the basis for establishing such limitations?

It would be incorrect to say that such limitations have been established. It would be nearer the truth to say that there are probably limitations. A quarter of a century ago a statement of even such a tentative nature might not have met with general support. The reason for the change is in the newer development of nuclear physics, where the principle of indeterminacy and the unpredictable movement of the electron around its nucleus have raised questions as to the rigidity of the physical mechanism. The reduction of any physical phenomena to a law of averages, in which the action of the individual particle, no matter how small, is not possible to predict, weakens the basis on which physical science has been built. Such a procedure may be useful in relating together the laws of the physical world, derived as statistical averages, with the laws of human behavior; but it does not strengthen the hands of the scientist who has been accustomed to work on the implicit assumption of rigid causality in the phenomena of nature.

Are we justified in basing philosophical conclusions on these newer findings in ultramolecular physics which seem to carry with them a certain air of indeterminacy? May it not be that further work will discover the factors which influence the movements which are at present unpredictable? Or must we accept the position and guide ourselves accordingly? It would seem to be dangerous to go far on the strength of data derived from the operation of non-observable phenomena. It might seem more advisable to urge caution in drawing conclusions until a closer approach has been made to the matter at issue. In the stream of literature which has poured forth on the subject in recent years, however, there has been general acceptance of the position that a new orientation is needed in our approach to the physical world, and that the scientist must guide himself accordingly. Let us examine some of the more important contributions which have been made towards an understanding of the world in this new setting.

Eddington accepts the indeterminacy which the modern findings of physics have proclaimed, and with it, as a necessary consequence, the relegating of the principle of causality to the dustheap. This is not to say, however, that it is a world of chaos with which we have to deal. Eddington does not go so far as to say that there may be a principle of volition in inanimate nature akin to that which he accepts in the realm of human consciousness. He bases his conception of the orderliness which may exist in nature on the statistical laws which hold good for nature's processes in the mass, whatever may be the capricious action of the minute individuals which make up the mass. It is the orderliness of the mortality rates of human beings, accurate for the purpose of insurance companies, but of no value to you or to me in forecasting our own span of life. But to him there is a world beyond those pointer readings which alone represent in our consciousness the expression of nature's working. The data of science are symbols of that of which we can not be conscious and which we are unable to apprehend. There is a mystical background in nature and in man which Eddington interprets, not as a scientist, but as a poet. Therein lie both the intangibility and the charm of much that he has written.

Eddington is a scientist with a philosophical outlook. Whitehead is a philosopher with a mathematical background. The approach of Whitehead is a different one to that of Eddington. Eddington's concern is to make clear the limitations under which the scientist works, and the reality of that other world, known only to our own consciousness and what we know of the consciousness of others, in which the intangible values hold sway. It is in effect a dualism, on the one hand of pointer readings which we build up into our body of scientific knowledge, on the other hand of values which come to us through other channels, but which commend themselves as enduring realities. Whitehead sees the special area in which the scientist works, but his concern is primarily to integrate this world of the scientist into the larger whole. He seeks for a representation of reality into which the inorganic and the organic world fit without distinction and without separation. To Whitehead all nature is an organism, of which that part known to science is only a part, but nevertheless an outward evidence of the inward whole. That nature is an integrated organism is an assumption which the philosopher, whose function it is to look out on truth in its most universal significance, may readily take as a premise to his thinking. It is the attitude of the poet, to whom all outward expression in nature is an indication of an inward spirit

which pervades the world, and gives it meaning. It is no easy task for the uninitiated reader to understand the way in which Whitehead's organism functions. It is less difficult to understand that in the ultimate analysis there may be a harmony in which mere arbitrariness has no part; and in Whitehead's words "to know that the system includes the harmony of logical rationality, and the harmony of esthetic achievement: to know that while the harmony of logic lies upon the universe as an iron necessity, the esthetic harmony stands before it as a living ideal moulding the general flux in its broken progress towards finer, subtler issues."

It would serve little purpose to discuss all the interpretations of the world of nature and of man which have been given to us in recent years. May I limit our attention to one other, from a man with a scientific background very similar to that of Eddington. Herbert Dingle is unsympathetic to the positions taken both by Eddington and by Whitehead. Eddington he finds to be illogical in that he has taken the position that "the only subject presented to me for study is the content of my consciousness," while he has at the same time admitted the reality of the external world on which the scientist operates. He has thus been disposed to attribute an element of the mysterious and mystical to this outside world, because it is outside the realm of consciousness. Dingle considers this to be an unnecessary consequence of inadequate premises. Whitehead's assumption, on the other hand, that there is an organism in nature which rationalizes in itself all that is perceived and all that is felt, Dingle considers to be an assumption without proof. As a scientist he feels that, while ultimately this may be found to be the case, it can not be assumed in advance. His plan is to build up, if the facts justify it, a basis of rationality in the more limited areas which are available for exploration with the limited means at our disposal, and to work outwards from this central nucleus until eventually a field theory may be developed which will rationalize the whole of nature. Einstein has gone part of the way in this direction in his field theory of gravitation. Dingle takes the position that in the ordinary world of everyday experience causality rules, and common-sense judgments are found. The scientist, however, deals with concepts, idealized from the common-sense everyday world; and in the world of concepts time has no meaning, and causality consequently has no validity. The electron is a concept, mass is a concept, light is a concept. The function of the scientist is to interpret the memory of experiences by concepts and to correlate these concepts into ever-widening wholes. Science abstracts from the world of experience. The more complete the abstraction, the less the sense of reality in the concept which is created.

I am reminded, as I ponder over the position taken by this able astrophysicist, of a conversation with a prominent member of the somewhat revolutionary group of Canadian artists, popularly known as the School of Seven. The discussion was on the representation of a tree which stood prominently in the center of a bare northern landscape. To me the tree was unreal and almost fantastic. As a lover of nature I registered my protest. It was explained to me that the function of the artist is to see an inner significance, to abstract it from the setting and to depict it by itself alone. So too, it was stated, the poet finds an inner significance, separates it from its extraneous environment and presents it as a central truth, independent and alone. Somewhat the same method, if one interprets Dingle aright, is adopted by the scientist. The concept of the electron, like that of the tree in the Canadian painting, stands isolated and unreal to the world of experience. It is a symbol of a central truth; true in essence, but symbolic when viewed from the position of the ordinary world of everyday experience.

These three interpretations of the validity of the scientific method, sketchy and incomplete though this presentation of them necessarily is, are profoundly significant. It is to be expected that there will be no unanimity in the approach to truth; and Eddington, Whitehead and Dingle are far apart in their interpretations. Man gropes for the ultimate, and groping means exploration in all directions. But they have things in common, and two of them seem to call for special emphasis in a discussion of the values of science to a modern world.

It is very evident, in the first place, that the rigidly mechanistic conception of the universe, as it appeared to an earlier generation of scientists, has lost its force to-day. It is not in the thinking of the men to whom I have referred, nor to others of similar stature who, too, have gone deeply into the subject. This change has taken place partly because scientists are not prepared to insist on the principle of causality in the face of the recent findings in nuclear physics; but mainly because they are doubtful whether the method of the scientist is adequate to determine the whole of the processes of nature, even in the purely physical realm. There are many who would feel that, when further knowledge has been gained, the mechanical principle may yet prove to be the most adequate interpretation. There are few who would take the position that it is the only interpretation of the phenomena of the inanimate and animate world.

In the second place, there is a growing tendency to treat nature as a whole and to make no separation between the inanimate and animate world. Whatever explanation will ultimately be found to be adequate must prove to be adequate for the living and non-liv-

ing alike. The mechanists endeavored to apply this principle to the whole of nature, and in so doing reduced man to an automaton. Freedom of choice disappeared in the process; and reason has rebelled against this explanation of the springs of our being. But it is felt that there must be a principle of rational operation of the world, and that man in all his activities, physical, intellectual, spiritual, will be found to fit into the plan as well as does the growing crystal. If there is not a closed system self-determining and working as does a machine, there must be a rational system, which the mind of man may yet be able to understand. The philosopher assumes that such a comprehensive system exists; the scientist feels that the proven area of rational operation is widening, and may some day include the universe in its scope.

These two positions, which seem to be representative of the thinking of our time, namely, that the mechanistic conception of the world is inadequate and that there will in all likelihood be found to be a rational basis applying to the inanimate and animate world alike—these positions have been taken because of a sense of values which has found inadequate interpretation under the old régime. Eddington has illustrated this sense of values in a memorable passage in which he describes his inner satisfaction in the contemplation of the ripples on the surface of a lake, touched by the afternoon sun; and by contrast his intellectual process in formulating the motion of the waves into a differential equation. Esthetic values seem to stand apart from the formulae of science. They must be accounted for. They must be accounted for in a wider synthesis in which science plays a fundamental part. And they must be accounted for not as an experience of human consciousness only. The glory of the afternoon sun over a lake in the northern woods, when it would seem that the very gates of heaven are rolled ajar and a fleeting glance is permitted of the eternal Presence—that glory is not in the mind of the worshipper only, and of no reality unless there is human consciousness to feel it. It is a value in nature, which goes back to a time when there was no human eye to perceive; it will be there when the procession of human beings has trod across this fleeting stage of time, and made the final bow to the audience of the stars. The quality of beauty resides in the essential fitness of things themselves, as in the mind attuned to perceive that fitness. The deeper values are universal, in and through nature, of which man is only a part. It is the great task of science to integrate these eternal values into a rational whole with the external phenomena of nature with which science has been hitherto more immediately concerned. Ultimately there can be no conflict; there can not even be a dualism. If truth has any meaning, it is that there is one truth, expressed it may be through many aspects, but blending into a unified whole. The tools adequate for the work of delving for this comprehensive truth must be shaped for the hands both of the scientist and the philosopher, for they must work together in this great quest.

In all our thinking we come back to the human sciences. It is in the realm of human activity and human aspirations that the ultimate test will be made. I have already indicated in the discussion that it is here that the gap between the findings of science and the whole truth has been felt to be greatest. It is here that the need for a clear understanding is most urgent. In the need for clearer thought as to ultimate values which we call good, whether in personal or social relationships, whether as formulated by legislation or by an inner moral law which finds no expression in words, can we advance to clearer criteria by the well-tried method which science has so successfully pursued elsewhere, or must we always be content to say, as the Earl of Listowel has recently said: "Here we turn for guidance, not to science but to the beating of our own hearts and to those great books of poetry, philosophy, and religion in which the finest of men have recorded what life could give in its highest, and happiest and most vivid moments. The sixth book of Plato's Republic, the thirteenth chapter of St. Paul's first letter to the people of Corinth, the Sermon preached by Jesus on the Mount—such brief communications as these are a better training-ground for those who would direct the affairs of nations than all the voluminous writings of Einstein, a Pavlov, or a Freud"?

In this problem of values, as McDougall has pointed out, we face the question not only and not so much of the "how" but of the "why" and "to what end." Evaluation involves purpose and direction; and it is there that the persistent question is being asked.

"O, I wad like to ken," to the beggarwife says I
"The reason o' the cause an' the wherefore o' the why
Wi' mony anither riddle brings the tear into my e'e."
"It's gey an' easy speirin," says the beggarwife to me.

The questions will up, and the human heart demands an answer. The answer is not easy. "It's gey an' easy speirin." The scientist has been concerned with the "how." He has confined himself to it. He has achieved great success in it. But he is beginning to realize that, somehow, the "how" and the "why" are inextricably bound up together, and the answer to the one involves an answer to the other. Ends and means are tied up in the same bundle of life. If he can deal with means alone as a scientist he must deal with ends as a man; but he would wish to use his ability and technique as a scientist in the whole field, and not in a part. Here is the attitude of the younger men in

the field. I quote from "Human Affairs." "Science is not a device for making self-filling fountain pens. Science unveils a new order of values; it demands another way of living. With its vast concept of being we may cast a new mould for the shaping of action. For there is an intrinsic beauty in the architecture of scientific thought, an intrinsic worth in acquiring its realistic type of thinking, a superb ethical discipline in the impersonal quality of its ends. To spread the scientific spirit in the community is a need of the first importance. We must infuse the neutrality of science into the partiality of human affairs. We must leaven the mentality of our age, still heavy with individualistic and archaic modes of thought, with the rationale of science. How else, if not by such an attitude, can the supremely urgent innovations so patiently contrived by the human sciences be made available?" And again, "We believe that the human race has only begun to unfold the infinite range of its possibilities."

There is no lack of confidence here. There is the ring of the optimism of youth, aware of the ground which has to be conquered. The nature of man requires the discipline which comes from the objectivity of science. The cravings of the human spirit have to be submitted to the corrective of the process of facing facts as they are or as they will yet be ascertained to be. Science provides a pattern of thought, to which if man would submit himself much of the shortsightedness and unwisdom of man and the structure of society which he has built up would disappear. These statements will command assent. And, if, further, the scientist, the moralist, the philosopher and the mystic can together search out the heights to which man is capable of climbing, the task of mapping out the path by which the toilsome and laborious ascent may be made is not beyond the power of science, in its wider sense, to perform.

In all this groping of science toward wider human contacts, what is the responsibility of those among us who are concerned with the education of young men and women, and with the validity of the means of education which lie to hand? Where does science now stand in the scheme of education for the needs of the world of our time and of the time of the generation that is to follow us? This is a question which has been in the background of my thinking as I have endeavored to paint the picture of the values of science as they appear to me in their changing form.

Two things impress themselves on me. The first is that the method and the attitude of science are indispensable for modern life and thought. No young men or women are equipped for life without that background, for they will live their lives in an atmosphere permeated with that outlook and that method. Without this equipment they are as passive spectators looking out on the active stream of life as it goes past, for they have not the technique to understand the significance of the processes of modern civilization. This is not to say that we are sound in all our procedure. The time has come, in my judgment, to question the value of the large amount of time which those who are not to be scientists spend in the laboratories of our modern universities. It is not improbable that more might be gained by observation of the method and the enthusiasm of the able teacher of science. But that method and that enthusiasm must in some measure be imparted to all who are to take their share in the work of our modern world.

The second consideration—and it is even more fundamental—is that this kind of education is not enough for our time. It is imperative that the young scientist should know something of the problems of the psychologist, the philosopher, the economist, the sociologist and the statesman. Not that he should be familiar with the details of those vast fields; that is not humanly possible. But it is possible, and it is necessary, that he familiarize himself with one of the realms of human relationships and feelings, in order that he may place his science in its setting for modern needs. The value and the influence of the man who works completely apart from, and without knowledge of, the deeper movements of mankind, grows less with the passing years; for he at least will play no part in that widening influence which science must exert on the solution of the problems which confront the human race. In this matter we are in grave danger. One contemplates with disquiet and apprehension the increasing stream of narrow specialists who issue from the institutions of learning into a world that is seeking for other counsel than they can give. We need the men who are imbued with the scientific spirit and who have access to the inner courts of the temple of the mind and the spirit of man. That kind of man must be cultivated in our halls of learning. Can it be that we are failing in our task?

We go forward in the faith that truth is universal, and that ever-widening areas will be mapped and explored. It is a small island from which we set out to chart that great sea. If science is to be our instrument, it must be capable of meeting heavy demands. For we will voyage into the infinite, beyond the last horizon.

'From this wave-washed mound
Unto the farthest flood-brim look with me;
Then reach on with thy thoughts till both be drowned;
Miles and miles distant though the last line be,
And though thy soul sail leagues and leagues beyond—
Still, leagues beyond those leagues there is more sea.'

OBITUARY

JAMES LAWRENCE KELLOGG

ON July 8, 1938, James L. Kellogg, professor emeritus of biology in Williams College, died at his home in Williamstown, Mass., after more than a year of serious illness. He was in his seventy-second year, having been born at Kewanee, Ill., on September 15, 1866. He received the B.S. degree from Olivet College (Mich.) in 1888, while Hermon C. Bumpus was professor of biology there, and this association was an important factor in his choice of biology as a profession. He went from Olivet to Johns Hopkins University, from which institution he received the degree of Ph.D. in 1892. The honorary degree of A.M. was conferred upon him by Williams College in 1900, when he had become a member of its faculty.

After receiving the doctor's degree at Johns Hopkins he was for seven years professor of biology in Olivet College (1892–99). From 1899 to 1903 he was assistant professor of biology at Williams College and from 1903 to 1934 he was professor of biology and head of the department there, in succession to Professor Samuel F. Clarke. In 1934, at his own request, he retired from active teaching and became professor emeritus.

During the long services of Professor Clarke, Williams College was noted for its excellent record in its undergraduate training of biologists. Into this Williams atmosphere and environment Dr. Kellogg, an outsider, came after his years at Olivet College, and it is eloquent testimony to his abilities as a teacher and his qualities as a man that he maintained the high reputation of the department of biology. On the 25th anniversary of his coming to Williams his former students united in a testimonial of their high regard for him in the presentation of a watch and a sum of money. From some of the many letters to the committee arranging the testimonial, I select the following expressions of esteem: "I do not know of any man to whom I feel that I owe more"; "I have a peculiar and lasting affection for Dr. Kellogg"; "No man of my day did more for me"; "He is by far the most inspiring teacher I have come in contact with." Similar testimony to his success as a teacher is contained in a letter from President Garfield in reply to Dr. Kellogg's request to retire from active service at the close of the academic year in 1934, a part of which I quote: "Permit me to say to you quite simply and directly that as a Williams man I appreciate sincerely the long and very excellent service that you have given to the College. I know with what affection you are regarded by a great host of those who studied under you, and you know of their affection for it has been manifested in many ways." The *Williams Alumni Review* for April, 1934, published a new photograph of Dr. Kellogg and a detailed story of his life, and commenting on his announced retirement after thirty-five years of service there, said: "Is it any wonder that such men as Samuel Fessenden Clarke, James Ingraham Peck and James Lawrence Kellogg captivated and held the life-long interest, with the love and affection, of hundreds of students! Is it any wonder that the older established sciences—astronomy, physics, chemistry—yielded in popularity to biology!"

He was first of all a teacher, and to this work he devoted most of his energies. His lectures were prepared with care and given with an enthusiasm and intensity that left a lasting impression on his hearers. This devotion to his students left him only the fag ends of his time for research, practically all of which was done during summer vacations. His research publications, while not numerous, are all marked by meticulous care in observation, illustration and description. His first important paper was on the "Morphology of Lamellibranch Mollusks," which was undertaken at the suggestion of Professor W. K. Brooks as a subject for his doctor's thesis. It was published in the *Bulletin* of the U. S. Fish Commission in 1892 and consists of some fifty pages of text and one hundred figures on the anatomy and histology of lamellibranchs, particular attention being given to the structure and phylogeny of the gills. This work determined the direction of all his further researches, which were devoted entirely to this group of mollusks.

In 1898 he was invited by Dr. Bumpus, then professor of biology at Brown University and a member of the Rhode Island State Fish Commission, to undertake a study of the life history of the common clam, together with the problem and possibilities of clam culture. This work was published in the Report of the Commissioners in 1899 and appeared in more extended form in the *Bulletin* of the U. S. Fish Commission for 1899. Again in the last-named series he published in 1904 a valuable paper on the conditions governing existence and growth of the soft clam (*Mya arenaria*). The possibility of utilizing large areas of tide flats for clam culture was emphasized in these and later publications. In 1901 he made a study of the clam and scallop industries of New York state and again in 1905 a study of the feeding habits and growth of the hard clam (*Venus mercenaria*), both of which were published in the *Bulletin* of the N. Y. State Museum for the years named. In 1905 he made a similar study of the marine food mollusks of Louisiana, which was published from the Gulf Biological Station of Cameron, La.

His recognized leadership in this field led to his

being invited to prepare a book for the American Nature Series (Henry Holt and Co.) on "Shell-Fish Industries." This book of 360 pages and 67 figures was published in 1910. It is charmingly written and is clear, humorous, literary and withal genuinely scientific. Naturally the story of the oyster occupies most of the book, namely, twelve chapters out of twenty-two. Other chapters deal with clams, scallops and general topics, such as anatomy, development, physiology, sea farming, interrelations of organisms, adaptations and design, etc. His last and in many respects most valuable original scientific contribution was on the "Ciliary Mechanisms of Lamellibranchs" (*Jour. Morph.*, 26, 1915). This study was begun in 1898 and later was continued in visits to all coasts of the United States. In this summary of years of work he describes these ciliary mechanisms in thirty different species, and his figures are so beautifully drawn that the Wistar Institute chose some of them as models for its style book.

He was a broadly trained naturalist with artistic temperament and in all his work showed what might be called a "perfection complex," which necessarily led him to limit the field of his research work but to do as thoroughly as possible all that he undertook. In his study of the shellfish he said he had traveled almost every mile of our Atlantic coast from Nova Scotia to Louisiana. He was particularly skilful with hand and eye, an excellent dissector and draughtsman, and his handwriting was like perfect copperplate. He loved the great outdoors and was a skilled photographer and an excellent shot with pistol and rifle.

In social relations he was reserved almost to the point of shyness, and his modesty and sense of humor prevented his thinking of himself more highly than he ought to think. But he was generous in appreciation of others and he bound his friends to him with bonds of real affection.

In 1892 he married Ida M. Archambault, of Buchanan, Mich.; to them were born four daughters, all of whom survive him. A host of former students and friends mourn with them the loss of a delightful and unselfish companion and a noble personality.

EDWIN G. CONKLIN

DANIEL WEBSTER HERING
1850–1938

DANIEL WEBSTER HERING, professor emeritus of physics and senior member of the faculty at New York University, died at his home in New York City on the 24th of March, 1938, at the age of 88 years.

Born on the 23rd of March, 1850, near Smithburg, Maryland, which lies on the western slope of the Blue Ridge Mountains, Professor Hering commenced his higher education in 1869 at the Sheffield Scientific School of Yale College, where he earned his Ph.B. degree in 1873. In 1876, when President Gilman opened the Johns Hopkins University primarily as a school for graduate study, we find Daniel Webster Hering among the first twenty fellows appointed to that institution, where he enjoyed the intellectual atmosphere surrounding such productive scholars as Sylvester, Remsen, Rowland and Martin. His field of study in this newly formed institution was civil engineering; and, there being at that time no regular provision for granting a degree in civil engineering at Johns Hopkins, credit for his scholastic achievements was transcribed to Yale, where he was granted the degree of civil engineer with honors in 1879.

In the years 1880 to 1884 he was professor of mathematics in Western Maryland College at Westminster, and in the following year became professor of physics at the Western University of Pennsylvania—now the University of Pittsburgh.

In accepting a position in 1885 as professor of physics and applied mechanics at New York University, Professor Hering commenced an association with that institution which was unbroken for a period of fifty-three years; barring a brief period of one semester at Western Maryland College, where he substituted for a professor who had gone overseas during the world war. While associated with New York University, Professor Hering was active as head of the department of physics until 1916, when he was retired. During the years 1902 to 1915 he was dean of the graduate faculty. From 1926 until his death he was curator of a very rare and valuable collection of some 1,800 clocks and watches donated to New York University by the late Mr. James Arthur.

In addition to these academic responsibilities, Dr. Hering was distinguished by the honorary degree of doctor of laws from the University of Pittsburgh in 1907; and again from New York University in 1917; in 1895 the Western Maryland College had conferred upon him the doctorate of philosophy. He became an honorary member of the Society of Phi Beta Kappa in 1887; was a fellow of the New York Academy of Science; and an early member, and later a fellow, of the American Physical Society.

In physics, as in other sciences, there are some who make important discoveries along the frontier of the great unknown; there are others, quite as worthy although often less spectacular, who step into the newly conquered territory, clear up the debris of battle and make habitable the ground gained. Of this latter type was Dr. Hering. His mind was ever keen in picking out what, in physical discovery, was really important. His pen was quick to record and transmit to his fellow physicists the latest investigations performed in foreign countries in what was then "modern physics."

He was alert in acquiring the technique of the production of x-rays and wireless waves following their discovery in Europe in the late nineteenth century.

This intellectual keenness in grasping the importance of new results is to be observed again in Dr. Hering's method of teaching. When the great Cavendish Laboratory was opened at Cambridge University in 1874 the laboratory method of instruction in physics was well inaugurated. This example was followed by Johns Hopkins University, where Rowland converted the kitchen of an old residence into a laboratory. Dr. Hering, realizing the value of this innovation, established an instructional laboratory by partitioning off a part of his lecture room at New York University. His convictions in this method of instruction are expressed in an article written by him in 1893 entitled "Laboratory Instruction in Physics."

Beyond the realm of physics Dr. Hering found many joys and interests in life. First among these was, perhaps, the James Arthur collection of timepieces. With characteristic energy he examined minutely every clock and watch and then prepared a careful catalogue of the collection. His enthusiasm for this work and his scholarly study of timepieces is splendidly portrayed in his beautifully illustrated book, "The Lure of the Clock," published by the New York University Press in 1932. Another major interest of Dr. Hering was the history of the public attitude toward science. This is exemplified in his very entertaining volume entitled, "Foibles and Fallacies of Science," published in 1924; and again in his James Arthur Lecture, delivered at New York University on April 2, 1936, dealing with "The Time Concept and Time Sense Among Cultured and Uncultured Peoples."

One can not conclude a minute to the memory of Daniel Webster Hering without reference to that remarkable mental and physical energy of his which remained, unabated, to the day of his death. Although suffering from impaired hearing for many years, he maintained an extraordinary sense of humor in every personal contact and radiated cheerfulness and enthusiasm to all who were fortunate enough to know him.

In 1881, Dr. Hering married Mary Hollis Webster, of Baltimore. Following her greatly lamented death in 1930, Dr. Hering continued living with his two daughters, the Misses Doris and Hollis Webster Hering, who survive him.

WILLIAM H. CREW
NEW YORK UNIVERSITY

RECENT DEATHS

COMMANDER MILTON UPDEGRAFF, professor of mathematics of the United States Navy, retired, formerly on duty at the Naval Observatory, died on September 12 at the age of seventy-seven years.

DR. WILLIS R. GREGG, chief of the United States Weather Bureau, died on September 14 at the age of fifty-eight years.

DR. JOHN CLEMENT HEISLER, emeritus professor of anatomy at the Medical School of the University of Pennsylvania, died on September 9 at the age of seventy-six years.

DR. JOHN JENNINGS LUCK, for fifteen years professor of mathematics at the University of Virginia, died on September 15 at the age of fifty-five years.

DR. JOHN B. WENTZ, associate professor of farm crops at the Iowa State College, died on August 24 at the age of forty-seven years.

DR. THOMAS C. HEBB, professor and head of the department of physics at the University of British Columbia, died on August 13 at the age of fifty-nine years. He had been connected with the university since 1916.

MARY FREYER MONTGOMERY, San Francisco, assistant clinical professor of surgery at the Medical School of the University of California, died on August 30 at the age of thirty-eight years.

WILLIAM ROBB BARCLAY, consulting metallurgist of the Mond Nickel Company, Ltd., of London, known for his work on the technique of non-ferrous metallurgy, died on September 16 at the age of sixty-two years.

THE death at the age of sixty-eight years is announced of Dean Reinhold Matsson, of Sweden, churchman and botanist.

SCIENTIFIC EVENTS

THE HERTY FOUNDATION LABORATORY

Industrial and Engineering Chemistry reports that the Pulp and Paper Laboratory of the Industrial Committee of Savannah, Inc., has become the "Herty Foundation Laboratory" under an act of the Georgia Legislature. The change took place last February. Up to that time the laboratory had been supported financially chiefly by the Chemical Foundation, Inc., and by contributions of the Industrial Committee of Savannah, supplemented by appropriations of the Georgia Legislature.

At the close of 1937 it became evident that the major part of these funds would not be available in future and that in the event that other support was not secured the laboratory faced possible closure. However, an emergency fund was raised by equipment

manufacturers under the leadership of C. Stewart Lee, of the Pusey and Jones Corporation of Wilmington, Del. Following this action, the Georgia Legislature made an appropriation of $20,000 at its special session, this being in addition to the $10,000 appropriated in the preceding regular session. These funds, with the continued contribution by the Industrial Committee of Savannah, ensured the financing of the laboratory for the current year.

The Georgia Legislature, looking to the future, created by special act the Herty Foundation, authorized to take over the equipment and operation of the laboratory and to receive contributions from other states and subdivisions thereof, individuals and corporations. The board of trustees of the foundation is made up as follows: Jas. Fowler, *chairman;* G. M. Bazemore, *vice-chairman;* Elliott W. Reed, *secretary-treasurer;* Harley Langdale; and G. E. Maddox.

It was determined to continue the past policies and purposes of the laboratory, making the information developed available to all and to cooperate with all agencies engaged in this field of work centered on systematic research to determine, with the use of standard paper-mill equipment and chemicals, what modifications are necessary to employ the fast-growing woods of the southern states for pulpwood and products manufactured therefrom.

At a meeting of the Board of Trustees of the Herty Foundation on August 6, at Lakeland, Fla., it was voted to carry out the work of the laboratory, according to the plans and intentions of the late Dr. Herty. Supervision of the business of the foundation will be in the hands of the chairman of the Board of Trustees and the secretary-treasurer. Charles Carpenter, assistant director of the laboratory since January, 1938, will continue in charge of the experimental operations.

THE FIVE-THOUSAND-YEAR TIME CAPSULE OF THE WESTINGHOUSE ELECTRIC COMPANY

THE Westinghouse Electric Company has made public letters that were placed in the 5,000-year time capsule to be deposited by the company on September 23 at the site of the New York World's Fair.

Dr. Einstein's letter, written in German, sums up his impression of the modern age in 161 words. The authorized English translation follows:

Our time is rich in inventive minds, the inventions of which could facilitate our lives considerably. We are crossing the seas by power and utilize power also in order to relieve humanity from all tiring muscular work. We have learned to fly and we are able to send messages and news without any difficulty over the entire world through electric waves.

However, the production and distribution of commodities is entirely unorganized, so that everybody must live in fear of being eliminated from the economic cycle, in this way suffering for the want of everything. Furthermore, people living in different countries kill each other at irregular time intervals, so that also for this reason any one who thinks about the future must live in fear and terror. This is due to the fact that the intelligence and character of the masses are incomparably lower than the intelligence and character of the few who produce something valuable for the community.

I trust that posterity will read these statements with a feeling of proud and justified superiority.

Dr. Millikan wrote:

At this moment, August 22, 1938, the principles of representative ballot government, such as are represented by the governments of Anglo-Saxon, French and Scandinavian countries, are in deadly conflict with the principles of despotism, which up to two centuries ago had controlled the destiny of man throughout practically the whole of recorded history. If the national, scientific, progressive principles win out in this struggle there is a possibility of a warless, golden age ahead of mankind. If the reactionary principles of despotism triumph now and in the future, the future history of mankind will repeat the sad story of war and oppression as in the past.

THE FEDERAL HEALTH PROGRAM AND THE AMERICAN MEDICAL ASSOCIATION

THE House of Delegates of the American Medical Association met in emergency session on September 17 with one hundred and seventy-five members in attendance. The meeting was called for consideration of the proposed Federal medical care program which was submitted at the National Health Conference in Washington in July and which requires an expenditure of $850,000,000 a year. The President's committee urged establishment of a Federal department of health, the secretary of which would be a member of the Cabinet. To this the association agreed, with the proviso that the secretary "must be a physician."

The report, adopted unanimously by the delegates, according to *The New York Times,* read in part:

We approve the principles of hospital service insurance which is being widely adopted throughout the country. We particularly recommend it as a community project. Experience in the operation of hospital service insurance or group hospitalization plans has demonstrated that these plans should confine themselves to provision of hospital facilities and should not include any type of medical care.

We recognize that health needs and means to supply such needs vary throughout the United States. Health needs usually depend on local conditions and therefore are primarily local problems. We therefore encourage county or district medical societies, with the approval of their state medical societies, to develop appropriate means to meet their local requirements.

In addition to insurance for hospitalization we believe it is practicable to develop cash indemnity insurance plans

to cover the costs of emergency or prolonged illness. Agencies set up to provide such insurance should comply with state statutes and regulations to insure their soundness and financial responsibility, and should have approval of county and state medical societies.

We are not willing to foster any system of compulsory health insurance. We are convinced that it is a complicated, bureaucratic system which has no place in a democratic state. It would undoubtedly set up a far-reaching tax system with great increase in the cost of government. That it would lend itself to political control and manipulation there is no doubt.

We recognize the soundness of the principles of workmen's compensation laws and recommend the expansion of such legislation to provide for meeting the costs of illness sustained as a result of employment in industry.

In urging full use of existing hospital facilities rather than building additional ones, the delegates reported that the stability and efficiency of many existing church and voluntary hospitals could be assured by payment to them of the costs of the necessary hospitalization of the medically indigent.

Concerning appropriation of funds for the indigent, the delegates said:

Since the indigent now constitute a large group in the population, we recognize that the necessity for state aid for medical care may arise in poorer communities and the Federal Government may need to provide funds when the state is unable to meet these emergencies.

In the face of the vanishing support of philanthropy, the medical profession will welcome the appropriation of funds to provide care for the needy, providing first, that the public welfare administrative procedures are simplified and coordinated, and second, that the provision of medical services is arranged by responsible local public officials in cooperation with the local medical profession and its allied groups.

We feel that in each state a system should be developed to meet the recommendation of the national health conference in conformity with its suggestion that: The rôle of the Federal Government should be principally that of giving financial and technical aid to the states in their development of sound programs through procedures largely of their own choice.

Seven physicians were appointed as a body to consult with Federal authorities on the national health program. They are: Dr. Irvin Abell, of Louisville, Ky., president of the association; Dr. Edward H. Cary, of Dallas, Texas; Dr. Walter E. Vest, of Huntington, W. Va.; Dr. Walter Donaldson, of Pittsburgh, Pa.; Dr. Fred Rankin, of Lexington, Ky.; Dr. Frederick Sondern, of New York City, and Dr. Henry A. Luce, of Detroit, Mich.

THE BRITISH AND AMERICAN ASSOCIATIONS

AT its Cambridge meeting (July 17–24) the British Association for the Advancement of Science took two actions which promise to have important effects upon its future activities and influence. The first relates to proposed reciprocal relationships between it and the American Association for the Advancement of Science; the second, to its obligations to society. It is doubtful whether decisions of equal importance have been taken previously by the British Association in the more than one hundred years since its organization.

For several years the question of possible closer cooperation between the British and American associations has been discussed informally without any definite conclusion having been reached. These discussions do not imply that there has been any lack of cordiality between the two associations. In fact, their organizations are similar and for 90 years since the founding of the American Association (British Association, founded in 1831; American Association, in 1848) the members of each association have been welcomed at the meetings of the other. British scientists have frequently attended meetings of the American Association, and American scientists in considerable numbers, especially in recent years, have attended meetings of the British Association. At the recent Cambridge meeting 62 scientists from the United States and 19 from Canada were registered, or a total of 91, out of a total registration just under 3,000.

Last June at the Ottawa meeting of the American Association a committee was appointed to confer with representatives of the British Association respecting possible closer relations between the two associations. The British representatives at the conferences, which were held just before the Cambridge meeting, were Lord Rayleigh, president for 1938; Professors F. T. Brooks and Allan Ferguson, general secretaries; Dr. O. J. R. Howarth, secretary, and Sir Richard Gregory, editor of *Nature*. The American representatives were George D. Birkhoff, president for 1937; Harold G. Moulton, vice-president and chairman of the Section on Social and Economic Sciences for 1936; Herbert E. Ives, vice-president and chairman of the Section on Physics for 1934, and F. R. Moulton, permanent secretary. The conferences of these committees led to the passing of two resolutions by the council and the general committee of the British Association. Upon the passing of similar resolutions by the American Association the proposed reciprocal arrangements between the two associations will go into effect.

Under the terms of the first resolution, each association will invite, on alternate years, a distinguished representative of the other association to deliver a principal address. The invited British scientist will deliver the principal address at the summer meeting of the American Association, and the invited American scientist will deliver an address second in rank only to the presidential address at the annual meeting of

the British Association. Evidently only scientists of very high standing and capable of delivering excellent addresses will be invited. There will be no limitations on the subjects that may be chosen or on the manner of their treatment, but it is expected that the addresses will be of the general quality of the presidential addresses of the two associations. It will, of course, be gratifying if from time to time the subjects treated are of international interest. Whether or not such subjects are chosen, the visiting scientists will add to the attractions of the meetings, and the publicity given their addresses by the daily press will promote cordial international relationships. It is hoped that the plan will prove so successful that it will be expanded to include corresponding arrangements with similar scientific organizations in other countries.

Under the terms of the second resolution, each association will elect as honorary members the principal administrative officers of the other association. The honorary members will receive the announcements and programs of the association to which they are elected. For example, the honorary members elected by the American Association will receive the general programs of the meetings, and also the four issues of SCIENCE each year which contain the preliminary announcements and the reports of the two meetings. The purpose of this reciprocal arrangement is to familiarize the officers of each association with the work of the other. Although the British and American associations are generally similar, each has its special excellent points about which the other might well know. The American Association certainly has much to learn from the British about organizing excursions and social functions, and especially about making the delivery of presidential addresses dignified and impressive events.

The British Association took another step which may mark a turning point in its history. In order to facilitate investigations of the interrelations of science and society and to promote cordial international relations among scientists, the council and the general committee authorized the organization of a division of the British Association to consider these special fields. The work of the new division will be directed by a committee to be nominated by the council of the association and elected by its general committee. The division is given very broad powers, including that of holding meetings at any times and places. In this more formal way the British Association will undertake to do even more than the American Association is attempting to do through its "Science and Society Conferences" organized by the Section on the Social and Economic Sciences.

F. R. MOULTON,
Permanent Secretary, A.A.A.S.

SCIENTIFIC NOTES AND NEWS

DR. ALBERT CHARLES CHIBNALL, professor of biochemistry at the Imperial College of Science and Technology, University of London, will give the Hepsa Ely Silliman Memorial Lectures for the year 1938 at Yale University. The title of his lectures is "Protein Metabolism in the Plant." The lectures will be seven in number; on October 12, 14 and 17, they will deal with protein metabolism in seedlings; the fourth lecture on October 19 will deal with the synthesis of amino acids and amides in the plant. The concluding lectures on October 21, 24 and 28 will deal with the general subject of protein metabolism in leaves.

DR. RICHARD E. SCAMMON, distinguished service professor in the Graduate School of the University of Minnesota, will give on September 23 a lecture before the New York University Chapter of Sigma Xi on "The universalist tendency in seventeenth century science and medicine as exemplified by the activities of the versatile Dr. Petty."

PROFESSOR C. O. E. BERGSTRAND, professor of astronomy in the University of Uppsala, has been elected correspondent for the Section of Astronomy of the Paris Academy of Sciences, in succession to the late Professor L. Picart, professor of astronomy in the University of Bordeaux.

THE Bene Merenti silver medal of the Bavarian Academy of Sciences has been awarded to Professor C. F. van Oyen, of Utrecht.

AT the recent meeting of the British Medical Association the Sir Charles Hastings clinical prize was presented to Dr. J. W. McFeeters; the Stewart prize to Sir Patrick Laidlaw and, as already reported in SCIENCE, the Dawson Williams Memorial prize to Professor Leonard Parsons. The Katherine Bishop Harman prize for 1938 was awarded to Dr. B. S. Platt.

THE Dr. Jessie MacGregor prize in medical science of the Royal College of Physicians of Edinburgh has been awarded to Dr. Susanne Paterson for her work on the therapeutic uses of progesterone.

DR. TRUMAN L. KELLEY, of Harvard University, was elected president of the Psychometric Society at the annual meeting held at the Ohio State University on September 7 and 8. He succeeded Dr. J. P. Guilford, of the University of Nebraska, who gave the presidential address, which was entitled "A Study in Psychodynamics."

DR. HAROLD F. BLUM, who recently resigned as associate professor of physiology at the University of California Medical School to join the staff of the

Washington Biophysical Institute, has been elected a member of the Association des Physiologistes de langue française.

ACCORDING to the *Museums Journal* the Museum Association of Great Britain at its annual meeting at Belfast elected the following officers and councilors: *President,* Viscount Bledisloe; *Honorary Treasurer,* D. A. Allan, Liverpool Public Museums; *Honorary Secretary,* D. W. Herdman, Art Gallery and Museum, Cheltenham; *Honorary Editor,* W. E. Swinton, British Museum (Natural History); *Councilors,* Charles Carter, Plymouth Museums and Art Galleries; Sydney L. Davison, Lady Lever Art Gallery, Port Sunlight; James Eggleton, Glasgow Art Galleries and Museums; E. I. Musgrave, Wakefield Museum and Art Gallery.

HAROLD L. HAZEN, associate professor of electrical engineering, has been promoted to a professorship and has been made head of the department of electrical engineering at the Massachusetts Institute of Technology. Professor Hazen succeeds Professor Edward L. Moreland, whose appointment as dean of engineering was announced during the summer.

DR. WILLARD E. HOTCHKISS, formerly president of the Armour Institute of Technology, expert in industrial management, has been appointed Maurice Falk professor of social relations at the Carnegie Institute of Technology. Dr. Hotchkiss will organize the new program of social studies for engineering students, thus getting under way an educational project which has been planned for several years and which is made possible by a grant of $500,000 to the endowment fund from the Maurice and Laura Falk Foundation of Pittsburgh. This gift was announced in December, 1937.

DR. FRANCIS OWEN RICE has resigned from the faculty of the Johns Hopkins University to become professor of chemistry and head of the department of chemistry of the Catholic University of America, Washington, D. C.

DR. WALTER THOMAS, formerly professor of phytochemistry in the department of agricultural and biological chemistry of the Pennsylvania State College, has been named professor of plant nutrition in the department of horticulture.

DR. SAUNDERS MACLANE has been appointed assistant professor of mathematics at Harvard University.

ROSCOE D. HUGHES, of the department of zoology at Columbia University, has been appointed associate in biology at the Medical College of Virginia.

PROMOTIONS made at the Medical College of the University of Virginia for the session 1938–39 are: Dr. Stuart Michaux, professor of gynecology; Dr. R. H. Courtney, professor of ophthalmology; Dr. R. Finley Gayle, professor of neuropsychiatry; Dr. Thomas W. Murrell, professor of dermatology and syphilology; Dr. Lee E. Sutton, Jr., professor of pediatrics; and Dr. William D. Suggs, assistant professor of gynecology. Dr. Wyndham B. Blanton resigned last session as professor of history of medicine and has been made associate professor of medicine. Dr. Joseph F. Geisinger has been appointed professor of clinical urology. In recognition of their many years of service to the institution, following their retirement on July 1, emeritus professors were appointed as follows: Dr. St. George T. Grinnan, pediatrics; Dr. Emory Hill, ophthalmology; Dr. E. P. McGavock, dermatology and syphilology; Dr. Charles R. Robins, gynecology, and Dr. Beverley R. Tucker, neuropsychiatry.

DR. GORDON M. SHRUM, professor of physics at the University of British Columbia, has been appointed head of the department.

DR. F. L. WELLS, formerly in charge of the Psychological Laboratory at the Boston Psychopathic Hospital, has been appointed psychologist to the department of hygiene of Harvard University. His office address is 13 Holyoke Street, Cambridge, Mass.

RALPH RUSSELL has been appointed to the staff of the Division of Fishery Industries of the Bureau of Fisheries as associate fishery economist.

DR. GEORGE F. POTTER, for the past eighteen years head of the department of horticulture of the University of New Hampshire, will take charge of the laboratory of nurseries and experimental farms in connection with the government project at Bogalusa, La., on the growth and development of the tung oil industry.

FRASER MACCARTNEY, student gardener from the New York Botanical Garden, will spend a year at the Royal Botanic Gardens, Kew. He is taking the place of P. A. Chandler, who will fill Mr. MacCartney's place in New York. This is the third exchange arranged under the auspices of the English-Speaking Union.

AT its meeting on July 25, the National Advisory Cancer Council recommended the following grants-in-aid: Harrison S. Martland, City Hospital, Newark, N. J., $1,425 for the further study of osteogenic sarcoma in radioactive persons; $7,500 to the University of Chicago for researches in carcinoma of the stomach in the relation of hormones to ovarian cysts and a study of carcinogenic substances in cancerous and precancerous tissue; $1,000 to B. R. Nebel, New York State Agricultural Experiment Station, for the study of the action of phenanthrenes on plant tissue cells;

3,452 to the University of Cincinnati for improvement in the diagnosis and treatment of cancer; $6,600 to the American College of Surgeons, Chicago, for a study of hospitals and clinics with reference to clinical cancer service; $4,200 to Dr. John J. Bittner, for a continuation of his studies on the relation of nursing to breast cancer in mice.

UNDER the direction of Edward P. Davis, topographical engineer of the U. S. Geological Survey, Glacier Park has been remapped. Prior to this summer no work had been done on the park since 1912. Twenty-five years later the National Park Service made several additions to the map of the U. S. Geological Survey. It is expected that the map will be available next year.

A SUB-OFFICE of the U. S. Geological Survey was recently established at Jackson, Mississippi, from which will be supervised the surface water investigational work conducted by the survey in cooperation with the state of Mississippi, as a result of cooperative funds provided by the last legislature. Edward B. Rice, associate engineer, will be in charge. He will be under the general supervision of the district office at Montgomery, Ala. A sub-office has also been established recently at Baton Rouge, La., resulting from cooperative surface water investigations started in that state. Ralph E. Marsh, assistant engineer, is in charge under the general supervision of the district office at Montgomery, Ala.

A SCIENTIFIC expedition left British Guiana on September 6 to collect specimens of the bird, animal and fresh-water fish life at the Roraima Plateau, on the British Guiana-Venezuela boundary. Members of the expedition include P. S. Peberdy, curator of the British Guiana Museum; A. Pinkus, representing the Michigan State Museum and the New York Botanical Garden, and T. Pain, curator of the Chelmsford and Essex Museum, England.

DISCUSSION

THE UNDERTOW

MOST of our elementary geological text-books contain definite statements regarding the existence and behavior of the undertow. It is described as a subaqueous, outward flowing current which is present when the wind blows perpendicularly on a lee shore. It is said to be caused by the piling up of the water as a result of the shoreward movement caused by the wind. This outward moving current is believed to have its movement modified at times so that it is slowed up or even temporarily reversed by each incoming wave, but its average movement is outward. It is generally regarded as being an important factor in the sorting and transportation of sediments on the underwater surface.

However, some years ago Professor W. M. Davis[1] raised the question as to the actual existence of such a current and presented a rather complete argument to show that what had previously been regarded as the undertow was only the backwash of the waves which had been mistaken by more or less frightened swimmers for an outward moving current. He ended his article by asking skilled swimmers to send in accounts of their experiences with shore currents.

In the replies received some expressed a disbelief in the existence of dangerous outward flowing subaqueous currents; other experienced swimmers were just as certain that, at least along some shores, such currents do present and sent in detailed accounts of their experiences.[2]

These replies were summed up in an article by Professor Davis[3] and there the matter was dropped for a time.

Recently Professor F. P. Shepard again brought up the question in an article, "Undertow, Rip Tide or Rip Current"[4] in which he expresses a disbelief in the undertow as generally understood but describes river-like movements of the water perpendicular to the shoreline running outward at intervals from a lee shore. These currents reach the surface and are said to occur a few hundred yards apart along a shoreline on which the waves are breaking. For this type of water movement he proposes the term "rip current."

With the above in mind a study was undertaken the past summer for the purpose of determining the existence or non-existence of the undertow. While the investigations as conducted did not prove the existence of an undertow that might be dangerous to swimmers, yet if by the term "undertow" is meant a current below the water surface that moves outward approximately perpendicular to the shoreline then the investigations show very definitely the existence of such currents under certain conditions, and the inference is very strong that they may be swift and dangerous during storms.

Obviously, direct observation of the behavior of the movements of the water is very difficult on a large body of water when a heavy sea is running. Therefore it was decided to begin the study by giving attention to the behavior of small water bodies. The first observa-

[1] SCIENCE, 61: 206–208, 1925.
[2] SCIENCE, 61: 444, 468, 1925.
[3] SCIENCE, 62: 30–33, 1925.
[4] SCIENCE, 84: 181–182, 1936.

tions were made in a small body of clear water on the South Canadian River bottom near Norman, Oklahoma. This pond was about 20 feet long, 6 or 8 feet wide and 10 inches deep with a quite uniform slope from the sides toward the center. A wind with an estimated velocity of 12 miles an hour was blowing lengthwise of it. Observation of the water movement was made by using ink and a medicine dropper. A little ink liberated near the bottom about two feet out from shore showed a very definite movement of the water to windward. A drop of ink on the surface indicated a relatively rapid movement of water to leeward. This upper layer of moving water was about an inch deep. Here, then, was shown at once a decided undertow. Further investigations showed that the surface of the water in the pond was moving to leeward and that the water underneath was moving to windward. This bottom movement of the water extended clear to the windward side, thus substantiating the statement which is sometimes made that on the windward side of a water body there is often a subaqueous current moving inshore.

Along the shores that were parallel to the direction of wind the water below the surface moved out toward the center for a few inches and then gradually turned with the main body of the windward moving water.

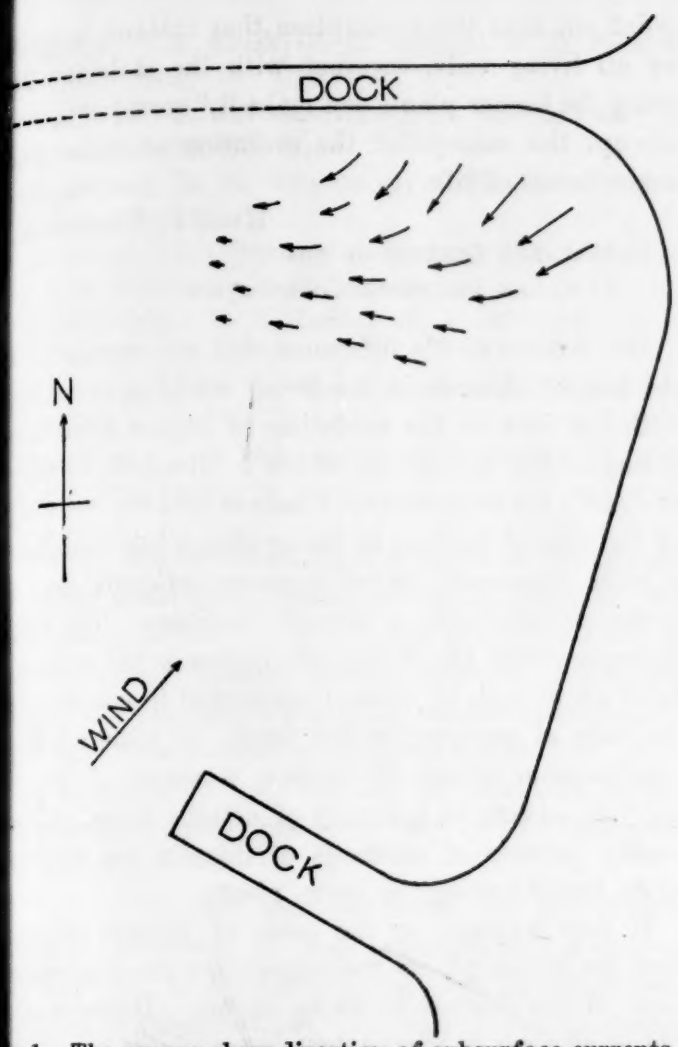
At the windward end of the pond the water surface was smooth, but the waves gradually increased to leeward until they were about 1¼ inches high and produced a miniature surf. Later observations made on some of the artificial lakes in the Wichita Mountain Game Preserve gave similar results. These lakes were several hundred feet across and 10 to 40 feet deep. It was not possible at the time to get out more than a few feet from shore, but it was found that in all cases observed where the wind was blowing on shore there was a current beneath the surface moving outward, and on the windward side there was always a subaqueous current toward the shore. The velocity of these currents was estimated to be between 6 and 15 inches per second. Their velocity varied with the wind and with the depth of the water; the greater depth giving the slower movement. These undercurrents were generally quite steady with very little pulsating movement except in the shallow water close to shore. Close to the bottom the rate of movement of the water was considerably decreased because of friction and very little pick-up of sediment occurred at these velocities. However, when the bottom was disturbed and some of the sediment put into suspension it moved readily with the current.

With the coming of the summer vacation the locality of the investigations was changed to the lakes of western Michigan. Here the first studies were in connection with some small temporary ponds on the Lake Michigan beach some distance south of the entrance to White Lake Harbor. The results were the same as those noted above with the added observation that the returning subaqueous current shows a very strong tendency to follow channels on the bottom of the pond. This study brought out very clearly the fact that the subsurface water is extremely sensitive to the forces acting on it and travels most readily where it meets with the least resistance. Consequently, when currents are present in a body of water the direction and velocity of their movements is very largely determined by the direction of the channels that may be present and the size and shape of their cross-section. Keeping this in mind is very helpful in studying currents in larger water bodies.

Following these studies on small ponds, investigations were made of subsurface currents on several lakes ranging in size from 4 to 16 square miles. On these lakes work could be carried out by wading and by using rowboats when winds prevailed of a velocity that would prevent work on Lake Michigan. The clearness of water in lakes of this region is such that by using colored liquids water movements can be easily observed to a depth of several feet.

The first study was made on White Lake along a shoreline that was straight except for a small bay about 50 feet wide that made an indentation of 3 feet. The wind, which had a fetch of about a mile, was blowing on shore with a velocity of 11 miles per hour. The lake bottom sloped outward about two feet per hundred. Observations along the straight shoreline outward for 50 feet showed no appreciable currents except a slight littoral drift in a few places. However, in the median line of the small bay in water 14 inches deep there was a distinct subsurface current outward with a velocity of about one foot per second.

The next observations were made in a bay-like enclosure formed by two old docks, as shown in Fig. 1. The slope of the bottom from the shore outward is 28 feet per mile. The water is so quiet that there is a considerable growth of weeds in the south and southeast part of the bay. The wind, which was from the southwest with a velocity of 14 miles per hour, caused waves that were sufficient to toss a small rowboat considerably. There are no weeds in the north side of the bay and along the old lumber dock a clear channel exists that deepens gradually to the west from the shore outward. Observations near where the old dock joins the shore showed that within about 25 feet of the shore the water was moving shorewards. The waves here were partly waves of translation. Whatever outward movement that was present was so hidden in the general confusion of the waters that it was not possible to detect any continuity. Between 25 and 50 feet from shore the water deepened from one foot to three



g. 1. The arrows show direction of subsurface currents.

et. Here there was a steady definite outward moving ndertow perpendicular to the shoreline with a velocity one and a half to two feet per second. The wind s not entirely steady, and when the gusts held for o or three minutes the velocity of the undertow was creased considerably. About 50 feet from shore this bsurface current turned gradually and ran parallel th the old dock out toward the center of the lake. was detected 75 to 100 feet further to the south but th decreasing intensity. As the current moved west- rd parallel with the dock it weakened as it came to deeper and deeper water until at a depth of six et it had almost disappeared. It will be noted that is subsurface water was moving west, while the wind d waves were from the southwest.

Again on the northwest side of Silver Lake, which circular in outline and about one and a half miles diameter, a gentle southwest wind of five miles per ur gave waves about six inches high and five feet g. At 40 feet from shore in one and a half feet water this caused a gentle but steady undertow.

Low ridges are frequently present on gently sloping der-water terraces on which there is a plentiful pply of sand. In the larger water bodies these lges tend to be approximately parallel to the shore- e. They are probably built by the waves and cur- nts during the heavier storms, but at other times they, themselves, exercise some control of the water movements. This was very noticeable on a part of Crystal Lake near Frankfort, Michigan. At Outlet Bay the underwater shelf extends out two thousand feet with a depth of only five feet at the outer edge. The bottom is of sand and gravel and the water is very clear. On this shelf are three sand ridges about one foot high and from 50 to 75 feet wide. The movement of the water on this shelf was carefully studied when the wind was blowing squarely into the bay from the north and the waves were about one and a half feet high. Between the beach and the first ridge, which was about 100 feet from the shore, no outward moving current could be detected, but there was some slight current at times parallel with the shore. However, on the offshore side of each ridge there was a definite but slow elliptical water movement as shown in Fig. 2. This was the general condition, although here

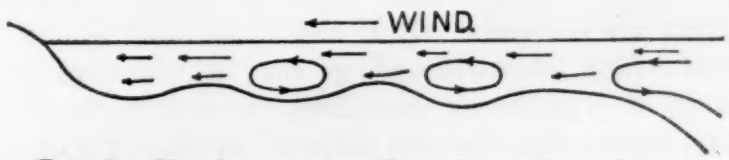


FIG. 2. Showing cross-section above the subaqueous terrace at Crystal Lake. Arrows show direction of currents.

and there a tendency toward a movement parallel to the ridges could be detected. So far as observed, the water movement over the ridges was toward shore but in some cases it was of an oscillating nature.

The studies described above were made on relatively small bodies of water. However, it is quite probable that the movements of water in small lakes are similar to the movements that take place in the larger water bodies under similar conditions. One strong indication of this is the uniformly successful results that have come from the use of working models at the U. S. Waterways Experiment Station at Vicksburg, Mississippi. Therefore these studies would indicate that with favorable conditions of wind, shoreline and bottom contour an undertow does exist.

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FERTILITY AND INTELLIGENCE OF COLLEGE WOMEN

IN a previous communication[1] it was reported that college men scoring high on intelligence tests at matriculation produce more children in the first dozen years after graduation than do those scoring low and that the differential which is significant in this result is age at marriage. It was desired to learn whether the same is true of college women.

The class of 1927 of the Women's (now Pembroke)

[1] R. R. Willoughby, "Fertility and Intelligence of College Men," SCIENCE, 1938, 87, 86–7.

College of Brown University was selected for study; its members were tested in 1923 with the Brown University Psychological Examination. The scores of several could not be used because no information on their reproductive histories was available; they were not significantly different in intelligence from the remainder of the group.

The total group was divided at the median into a high-scoring and a low-scoring group of 54 subjects each; 36 live births had been reported for the former and 37 for the latter. Further subdivisions were made to correct for inequalities among the dates of latest reproductivity information, but no significant differences appeared beween the groups. A comparison of marriage dates also revealed no significant differences.

While these data are obviously inadequate, the tentative conclusion may be drawn from them that test intelligence is not a factor in the reproductive histories of college women, at least so far as the most fertile years are concerned. It is also incidentally evident that college women, like college men, fall considerably short of reproducing themselves. It is to be hoped that these conclusions and those of the inquiry previously referred to may be repeatedly examined as more data become available on the reproductive histories of the early test populations.

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THE ROLE OF THIAMIN IN ORGANIC EVOLUTION

IN connection with the article of Dr. R. R. Williams (SCIENCE, June 24, 1938), it may be of interest to point out that the assumption that thiamin is needed by all living cells, together with the statement that "only the higher plants can make it," would completely disrupt the concept of the evolution of higher from lower forms of life.

HUGO P. KORTSCHAK
EXPERIMENT STATION OF THE
HAWAIIAN PLANTERS' ASSOCIATION

DR. KORTSCHAK'S inference that my conception of the role of thiamin in the living world is at variance with the idea of the evolution of higher from lower forms of life is not one which I intended the reader to draw. On the contrary, I believe that our knowledge of the rôle of thiamin in living things has contributed a most important bit of chemical evidence that all forms of life have a common heritage. The single sentence which Dr. Kortschak quotes is taken from a brief paragraph in which I attempted to condense for the sake of perspective the results of some scores of experimental studies by various workers. It accordingly is lacking in accuracy of detail. Some, at least scanty, powers of synthesis of thiamin are doubtless to be found among the lower plants.

It does appear, on the basis of present evidence, that the higher plants are responsible for synthesizing most of the thiamin in living nature. However, it is not at all clear to what extent lower plants have failed to develop ample synthetic powers in this respect and to what extent past powers may have been lost through symbiotic or saprophytic habits.

R. R. WILLIAMS
BELL TELEPHONE LABORATORIES

SOCIETIES AND MEETINGS

AMERICAN GEOPHYSICAL UNION

THE *Transactions* of the nineteenth annual general assembly of the American Geophysical Union and the meetings of its seven sections, held from April 27 to 30, 1938, at Washington, D. C., and of regional meetings at Spokane, Wash., December 28 and 29, 1937, and at Davis, Calif., January 7 and 8, 1938, are now in press. Part I of 585 pages relates to the Washington meetings, and Part II of some 160 pages relates to the regional meetings.

Because of the importance of the minutes of the general assembly and of those of the sections, with their appendices, in the general view of the development of the union and of their interest to all its members, they have been included, for the first time, as a part of the *Transactions*. The total attendance of members and guests—534 at Washington—marks the character of the meetings in 1938 and the growing import of the union as a factor in the progress of geophysics in the United States. The attendance at the regional meetings also emphasizes this progress.

Included in the minutes are the reports of officers and of standing, special and research committees. Especially noteworthy are those of the newly formed planning and project committee and of the two committees on geophysical and geological study of oceanic basins and on geophysical and geological study of continents. These show the many problems calling for intensive theoretical research and potential possibilities of their applications in profound problems of earth physics.

The respective presidents, vice-presidents and secretaries of the union and its sections for three-year terms, July 1, 1938, to June 30, 1941, except as otherwise noted, are:

Union: R. M. Field; W. C. Lowdermilk; J. A. Fleming (1937–1940).

Geodesy: C. H. Swick; R. M. Wilson; W. D. Sutcliffe (1937–1940).

Seismology: J. B. Macelwane; H. E. McComb; F. Neumann (1936–1939).

Meteorology: R. H. Weightman; C. W. Thornthwaite; H. D. Harradon.

Terrestrial Magnetism and Electricity: E. O. Hulburt; E. A. Eckhardt; J. Wallace Joyce.

Oceanography: C. E. Iselin; G. F. McEwen; P. C. Whitney.

Volcanology: E. G. Zies; Adolph Knopf; James Gilluly.

Hydrology: L. K. Sherman; J. E. Church; K. H. Beij (all 1936–1939).

Four of the six resolutions adopted at the general assembly relate to magnetic survey of the land- and water-areas of the United States, geophysical survey of the Central Atlantic States, location of meteorological stations and meteorological research-projects. The other two resolutions express thanks for privileges extended at the Washington meetings by the Smithsonian Institution and the U. S. Geological Survey.

Preparations are well advanced for the seventh triennial assembly of the International Union of Geodesy and Geophysics, to be held in September, 1939, at Washington, D. C. During the nineteenth annual meeting of the American Geophysical Union, one evening was devoted to a smoker to discuss these preparations and to formulate further plans. This will be the first assembly of the International Union in the United States since its formation in 1919. It will afford opportunity to reciprocate the courtesies shown us at the six assemblies in Europe and to inform our foreign colleagues of the extent of geophysical research and interests in the United States. It is hoped especially that all the nations of South and North America will avail themselves of the opportunity to take active part in the Washington assembly.

The scientific session of the general assembly in 1938 was devoted to a symposium on the physics of volcanic processes. Five formal papers presented were: "Introductory—Applying Physics to Volcanoes," by Arthur L. Day; "Surface-Manifestations of Volcanic Activity," by E. G. Zies; "Structural Development of Volcanic Cones," by T. A. Jaggar; "Rock-Structures Associated with Some Ancient Volcanoes," by Chas. B. Hunt; "The Roots of Volcanoes," by Reginald A. Daly. Following a summary of the symposium by L. H. Adams, there was an extended and searching discussion.

In the Section of Geodesy 15 papers and reports were presented at two sessions. Five of these dealt with progress and development of geodetic operations and instruments in Canada, Central America, Mexico and the United States; seven related to gravimetric surveys, apparatus, interpretations and relation of gravity-anomalies and geologic structure; one each related to improvement of time-service and broadcasting, to sea-level datum and to the mathematical treatment of accidental and other errors.

The Section of Seismology held one session. The 12 communications may be classified as follows: Theoretical interpretations and analysis, 4; individual earthquakes and seismic measurements, 2; seismic instruments, 3; microseisms, 1; geophysical investigations of geologic structure, 1; progress-report for the United States, 1.

The Section of Meteorology heard six papers at one session. These concerned ultra-violet solar radiation (2), velocity of sound-waves (1), compilation of observations (1), expeditions (1) and meteorological aspects of radio-transmission phenomena (1).

Sixteen communications were presented at the session of the Section of Terrestrial Magnetism and Electricity. These related to instruments and technique (3), ionosphere and magnetic correlations (2), cosmic radiation (2), solar relations (1), fossil magnetization as determined from ocean-bottom core-samples (2), secular variation (1), auroral-zone currents (1), possible seismic and magnetic relations (1) and terrestrial electricity (3). The secretary submitted brief summaries of progress-reports dealing with magnetic and electric researches received from five organizations on work in Peru, Western Australia and the United States, including Alaska, Hawaii and Puerto Rico.

Ten papers before the meeting of the Section of Oceanography concerned progress during the year of four governmental and private organizations doing oceanographic work in the United States. One paper each related to the Gulf Stream System, deep-sea measurements without cables, chemical oceanography, an international program for collecting samples of ocean-water and methods of representing suboceanic relief on maps. A report from the International Commission on Continental and Oceanic Structure gave important features relating to an international program arranged for cooperative gravimetric work at sea.

At two sessions of the Section of Volcanology 12 papers dealing with igneous rocks and effects of temperature and pressure were read and discussed.

One of the important features of the nineteenth annual meeting was a joint meeting of the Sections of Meteorology and Oceanography. The 13 papers presented at the two sessions of this joint meeting were devoted to a symposium on atmospheric and oceanic circulation.

There were four sessions of the Section of Hydrol-

ogy for the presentation of reports and papers. Twenty-four papers, with discussions, may be roughly grouped as follows: Rainfall, infiltration and ground-water, 15, and one appendix; stream-flow and flood-control, 6; and one each on evaporation, on glaciology and on contributions of the Water Resources Committee to hydrological investigations. The annual reports of permanent research committees were received and discussed as follows: (1) Snow; (2) glaciers; (3) evaporation from water-surfaces; (4) runoff; (5) physics of soil-moisture; (6) underground waters, with three appendices; (7) dynamics of streams; (8) chemistry of natural waters; (9) rainfall. Reports were also presented by newly formed special committees as follows: (1) Soil Conservation Service; (2) flood-waves, with six appendices; (3) density-currents. The total of 45 reports and papers affords evidence of the activity of the section.

The regional meetings of the Section of Hydrology at Spokane, Wash., and Davis, Calif., were arranged by special committees, of which W. A. Lamb and Morrough P. O'Brien were chairmen, respectively. Only three formal hydrological papers were presented before the North Continental Divide regional meeting at Spokane, the time being largely devoted to conferences and discussions; this meeting was held in affiliation with the Northwest Scientific Association.

The South Pacific Coast regional meeting at Davis, Calif., was held jointly with the Western Interstate Snow-Survey Conference. Sixteen formal hydrological papers were presented at three sessions, January 7 and 8, 1938. These related to hydrometeorology, precipitation and vegetation, evaporation, transpiration, forest and range hydrology (in relation to water-supply, forest management, live-stock industry and flood-control), floods, flood-control, evaporation and runoff from snow and studies in quality of irrigation-water. Nineteen reports and papers were presented and discussed at the Snow-Survey Conference on development of snow-surveying, methods of forecasting, economic aspects of snow-surveying, improvement of snow-survey equipment and winter sports. This meeting was concluded with a round-table conference and dinner.

The present *Transactions*, edited by the general secretary, include either in full or in abstract in Part I 140 papers and reports presented at Washington, and in Part II 38 papers and reports not elsewhere reported, with discussions presented during the regional meetings at Spokane and at Davis.

These *Transactions* afford further evidence of the scientific and economic value of geophysical research and of the contribution of the union through its coordination of many agencies. Further substantial progress may be confidently expected through the activities of the special committees of the union and of its sections, including the newly created planning and project committee.

JNO. A. FLEMING,
General Secretary

SPECIAL ARTICLES

THE SURVIVAL OF PLANT CELLS IMMERSED IN LIQUID AIR

A REVIEW of the literature[1] on the survival of plants or animals exposed to extremely low temperatures reveals that two kinds of organisms can support an immersion in liquid air (about −190° C.): (1) Those which resist a previous drying, *e.g.*, seeds, spores, protozoan cysts, tardigrades, nematodes; (2) those which do not exceed a few micra in size, *e.g.*, bacteria, yeast, monocellular algae, flagellates of the type trypanosome. This observation suggests that the survival might be due to the fact that water does not crystallize in these organisms, either because there is not enough water left in them to freeze, or because, on account of their small size and relatively large area, so much water can be withdrawn from them by osmosis during the congelation of their culture medium that they are practically desiccated. (The resistance to congelation offered by capillarity does not seem to be sufficient, alone, to explain the cold resistance of micro-organisms.) If then, crystallization of water is the factor responsible for death by low temperature, all the cells in which formation of ice can be prevented should survive. In the research reported here, we intended to study if and to what extent protoplasm vitrified at low temperatures (as described in a previous work[2]) that is, protoplasm hard and breakable like glass, but in which water had not crystallized, keeps its vitality.

In the work just mentioned, it has been shown: (1) That gelatin gels containing 37 to 90 per cent. water can be brought into the vitreous state by a sudden immersion in liquid air; (2) that the thickness of the vitrifiable layer decreases with increasing water-content, extending from 0.3 mm to a few micra when the water content varies from 50 to 90 per cent.; (3) that the temperatures at which the material crystallizes cover a range of some 15 degrees only (from 0° to about −15° C.) and that crystallization takes place either during a cooling from the atmospheric to sub

[1] B. J. Luyet and P. M. Gehenio, *Biodynamica*, No. 33, 1938.

[2] B. J. Luyet, *Biodynamica*, No. 29, 1937.

ero temperatures or during a warming from the lower emperatures to above −15°; (4) that the possibility f obtaining the vitreous state depends primarily on he velocity of crystallization; pure water could not e vitrified on account of its excessively high crystallization velocity,[3] while gelatin gels are capable f vitrification in proportion to the slowness of their rystallization, that is, in proportion to their gelatin oncentration.[4] The relation between the possibility f vitrification and the crystallization velocity is due o the fact that the vitrifying procedure consists essenially in cooling rapidly enough to bring the temperaure of the material across the zone of crystallization emperatures (from 0° to −15°) before the ice crystals ave time to form.

This method of vitrification could be applied to ntire plant leaves.[2] But preliminary experiments on he vitality of entire leaves gave results which sugested that some cells or tissues were alive, while some thers were dead. We then investigated the tissues ingly, beginning with the epidermis. This tissue can e obtained in monocellular layers thin enough for the xtremely rapid cooling required, it stays alive a long me after being separated from the plant and it lends self to several vitality tests. The present report is oncerned only with investigations on the vitality of he epidermis.

Pieces of onion epidermis previously stained with eutral red and differentiated with potassium hydroxde—a procedure which allows the living and the dead ells to be distinguished by their color[5]—were mounted small metal clips in such a way that each side of the issue presented an exposed area of about 20 mm.[2] he preparations were then immersed in liquid air. hen removed therefrom and brought back, in air, to oom temperature, the cells were all dead, as Becquerel, ho made similar experiments on the same material, as also observed.[6] Comparing these results with those eported above on the vitrification of gelatin, we ought that the epidermal cells might behave as the ls containing 90 per cent. water which, to be vitried, must either be reduced to a thickness of a few iera or lose some of their high water content. We en tried to dehydrate them by plasmolysis.

Stained pieces of epidermis immersed for about 15 econds in a 5 per cent. solution of sodium chloride, ere mounted as indicated above and, after removal, ith a blotter, of the excess plasmolysing solution, ey were immersed in liquid air. On being withdrawn om it, they were brought back, in air, to room temerature; the cells were all dead.

[3] J. H. Walton and R. C. Judd, *Jour. Phys. Chem.*, 18: 22, 1914.
[4] E. H. Callow, *Proc. Roy. Soc. A.*, 108: 307, 1925.
[5] B. J. Luyet, SCIENCE, 85: 106, 1937.
[6] P. Becquerel, *Comptes rendus Ac. Sc.*, 204: 1267, 1937.

Assuming that death might have resulted from a congelation during the too slow warming of the material in the atmosphere after its exposure to liquid air and that warming in a liquid medium would be more rapid on account of the better heat conductivity afforded by the liquid contacts, we immersed the preparations in the plasmolysing solution after their treatment in liquid air. Several cells were now found intact and could be deplasmolysed or plasmolysed to a further extent, when put in a more concentrated solution of sodium chloride.

If, instead of a 5 per cent., we used a 10 or 15 per cent. plasmolysing solution, before and after immersion in liquid air, more of the cells were intact.

The fact that, to save the cells from disintegration, one must use the same means as for saving a gelatin gel from crystallization, that is, (1) dehydrate them, (2) cool them rapidly, (3) warm them rapidly; and the fact that the further the dehydration the more resistant are the cells to injury or the gels to crystallization, suggest that the same fundamental process takes place in the two cases, in other words, that disintegration of protoplasm subjected to extremely low temperatures is due to crystallization and that any method, such as vitrification, which prevents crystallization, prevents protoplasmic disorganization.

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INSULIN AND THE OXIDATION OF ETHYL ALCOHOL BY EXCISED DIABETIC LIVER TISSUE

A RECENT study in this laboratory of the action of insulin in increasing the rate of disappearance of alcohol from the blood has indicated that the acceleration of glucose oxidation by insulin catalyzes the oxidation of alcohol.[1] It seemed to us that conclusive information regarding this relation might be gained by a study of excised tissue from an animal completely deprived of its insulin supply by pancreatectomy. So far only liver has been extensively studied, since this tissue is probably responsible for the major portion of alcohol oxidation.[2, 3]

Cats were employed for this study because pancreatectomy in this species results in severe diabetes. The pancreas was removed aseptically under anesthesia; and the animals were given adequate food and laboratory care until the diabetes became maximal.

[1] B. B. Clark and R. W. Morrissey, *Am. Jour. Physiol.*, (Proc.), 123: 37, 1938.
[2] E. Lundsgaard, *Compt. rend. Trov. Lab. Carlsberg*, 22: 333, 1938.
[3] L. F. Lelior and J. M. Muñoz, *Biochem. Jour.*, 32: 299, 1938.

The animals were then sacrificed and 500 mgm of the excised liver tissue were suspended in 6 cc of saline phosphate pH 7.4 contained in glass-stoppered 125 cc Erlenmeyer flasks. Both the experimental flasks and control flasks containing killed tissue had identical quantities of alcohol approximating 2.5 mgm. All flasks were filled with oxygen and incubated for 3 hours at 37° C. with continuous agitation. After $ZnSO_4$ precipitation, the entire contents of the flask were subjected to steam distillation, and the alcohol in the distillate determined by Harger's method.[4]

Under the experimental conditions outlined, 19 observations on 8 cats disclosed that an average of 23.5 per cent. of the alcohol present was oxidized by normal cat liver tissue in 3 hours; individual experiments ranged from 16 to 39 per cent.

In marked contrast, 17 observations on liver tissue from 7 diabetic cats depancreatized for 72 to 96 hours revealed an average oxidation of only 3.1 per cent. with a range from −0.5 to 6.2 per cent. Since the maximal limit of error for the measurement of the alcohol under the conditions employed is 4 per cent., it seems probable that only very small amounts of alcohol were oxidized. The completeness of the diabetes was indicated by respiratory quotients slightly below 0.70 for excised kidney tissue from these animals.

Liver tissue from one cat depancreatized, but maintained on adequate insulin for 90 hours after pancreatectomy, revealed an oxidation of 36 per cent. This further indicates that insulin is the specific factor concerned.

Additional evidence was obtained in two experiments on animals that had been depancreatized 72 hours previously. A lobe of liver was removed under anesthesia, and then immediately afterward, 20 units of insulin were given to one cat and 14 units to the other. Approximately five hours later, the animals were sacrificed and another portion of liver tissue removed. The ability of the liver tissue from the same animal, with and without insulin, to oxidize alcohol was then compared. With the diabetic tissue there was practically no oxidation (+0.3 and −0.56 per cent.), but after the administration of insulin 29.4 and 27.5 per cent. of the alcohol present was oxidized.

While the oxidation of alcohol by normal cat brain is relatively small, preliminary experiments have suggested that oxidation by diabetic brain tissue is still less. We are now studying the effect of experimental diabetes on alcohol oxidation by the intact animal.

These experiments indicate that insulin is necessary for the oxidation of ethyl alcohol by cat liver tissue. It is not yet evident whether insulin acts specifically on the alcohol oxidation system or indirectly through carbohydrate metabolism. In a complete report to be published later, data concerning the mechanism of this action will be discussed.

[4] R. N. Harger, *Jour. Lab. and Clin. Med.*, 20: 746, 1935.

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ALBANY, N. Y.

VITAMIN E AND AVIAN NEUROLYMPHOMATOSIS

BUTLER and Warren[1] have reported that vitamin E, supplied by injection or feeding of cold-pressed wheat germ oil, resulted in quick recovery from a paralysis which they indicated to be *neurolymphomatosis gallinarum*. They also claimed that adding wheat germ oil to the diet reduced the incidence of related diseases. Their statements are not supported by any definite figures, although their study "involved about 1,000 paralyzed birds."

Those who come in contact with the industry recognize the seriousness of avian neurolymphomatosis and the allied neoplastic conditions. Such methods of reducing mortality to the extent claimed by Butler and Warren would be well worth the expense of the added wheat germ oil.

The writer has investigated the curative effect of wheat germ oil in a study of 41 fowls showing clinical symptoms of fowl paralysis from the research flocks of this department. Ten of these birds were treated by intraperitoneal injection, 21 by feeding, and 10 birds served as non-treated controls. The source of vitamin E consisted of two lots of cold-pressed wheat germ oil, one of which had been lecithinized to reduce rancidity. These birds were, for the most part, White Leghorns of from 9 to 12 months of age. The procedure included recording (1) the symptoms and date of entry to the test and (2) gross lesions found during a complete routine autopsy. All hens were kept in flat-bottom battery cages with food and water easily accessible. They were not removed for autopsy until extremely emaciated or completely paralyzed for more than one day. The duration of the tests varied from 3 days, in extreme cases, to more than three months in less severe cases.

Ten fowls received wheat germ oil injected intraperitoneally, 1 cc per day, later reduced to 0.5 cc per day. Three of these received a total of 2 cc per bird, 3 got 3 cc each, 2 got 4 cc each, and the other two received 8 cc each of the wheat germ oil. Eight of these 10 birds showed at autopsy gross lesions of neurolymphomatosis involving the sciatic, brachial or

[1] W. J. Butler and D. M. Warren, *Jour. Amer. Vet. Med. Assoc.*, 92 (N. S. 45): 204–206, 1938.

abdominal nerves. The symptoms noted for one bird were "injury or paralysis of the right leg." This one improved and was returned to the laying pen. She was probably injured rather than paralyzed. Another fowl showed symptoms of unsteadiness on legs and jerking head movements. This bird apparently recovered, but one of the controls showing similar symptoms recovered without any treatment and hatched 33 out of 34 eggs in the past breeding season.

Twenty-one hens were fed wheat germ oil, 14 receiving 6 cc or more, and of these fourteen, 8 received 14 cc or more. Of the 21 birds 14 showed at autopsy gross lesions of neurolymphomatosis, one showed lymphomatosis of the liver, another showed tumors of the feet, comb and internal organs. Two others, with typical symptoms, were negative. Of two birds with uncoordinated head movements, one improved and laid 29 eggs in the next 50 days. The other is still affected, showing no improvement.

Of the 10 controls 7 showed gross lesions of neurolymphomatosis on autopsy, one showed lymphomatosis of the liver and ovary, and one which had shown only uncoordinated head movements as symptoms was negative. One bird returned to laying condition for a brief period but eventually died. This hen never regained control of its paralyzed right leg. One bird (mentioned above) recovered completely.

Fowls showing uncoordinated head movements, twisting of neck to one side or over the back, generally eventually die of inanition. In some cases gross and microscopic lesions of neurolymphomatosis have been observed in the eighth or ninth cranial nerves of these birds. In other cases it is doubtful if the condition actually represents true neurolymphomatosis.

The evidence presented, involving 31 paralyzed fowls treated with cold-pressed wheat germ oil in amounts similar to or greater than those suggested by Butler and Warren, does not support their contention that vitamin E or wheat germ oil can bring about quick recovery from true *neurolymphomatosis gallinarum*.

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A PARADOX IN THE SCORING OF COMPETING TEAMS

LET us suppose that a number of teams of three men each are competing in an academic contest and that the best three teams are to be selected on the basis of a special examination. How shall the merits of the several teams be computed?

Two possible methods of scoring suggest themselves: (1) we may list all the contestants in order of rank, and define the rank of each team as the sum of the ranks of its members; or (2) we may consider only the actual examination-grade of each contestant, and define the score of each team as the sum of the scores of its members. The first method we may call the rank method, the second the sum-of-the-grades method.

The rank method is regularly used in scoring intercollegiate cross-country runs. It should be noted, however, that the situation in the case of the cross-country run is not the same as the situation in the case of the academic examination. In the athletic contest, the order of rank in which the men cross the finishing line supplies the only data available (since the individual times are not usually recorded), while in the academic case we have not only the rank of each contestant but also his actual examination-grade, on the basis, say, of 100. The sum-of-the-grades method is used in the popular frog-jumping contests. Here the score for each "team of three" (consisting, to be sure, of three jumps of a single frog) is computed by adding the lengths of the individual jumps recorded for that team.

In many practical cases it will make no difference which method is used. Nevertheless, the question has a certain theoretical interest which seems to be worth discussing.

The purpose of the present paper is to show that

TABLE I

I			II			III			IV			V			VI		
B_1	98	1	B_1	98	1	B_1	98	1	B_1	98	1	B_1	98	1	B_1	98	1
						D_1	97	2	D_1	97	2						
A_1	96	2	A_1	96	2	A_1	96	3	A_1	96	3	A_1	96	2	A_1	96	2
D_1	94	3				D_2	94	4									
C_1	93	4	C_1	93	3	C_1	93	5	C_1	93	4	C_1	93	3	C_1	93	3
A_2	92	5	A_2	92	4	A_2	92	6	A_2	92	5	A_2	92	4	A_2	92	4
D_2	91	6	D_1	91	5												
C_2	89	7	C_2	89	6	C_2	89	7	C_2	89	6	C_2	89	5	C_2	89	5
			D_2	88	7							D_1	88	6			
B_2	87	8	B_2	87	8	B_2	87	8	B_2	87	7	B_2	87	7	B_2	87	6
C_3	84	9	C_3	84	9	C_3	84	9	C_3	84	8	C_3	84	8	C_3	84	7
												D_2	83	9	D_1	83	8
B_3	82	10	B_3	82	10	B_3	82	10	B_3	82	9	B_3	82	10	B_3	82	9
									D_2	81	10				D_2	81	10
A_3	80	11	A_3	80	11	A_3	80	11	A_3	80	11	A_3	80	11	A_3	80	11
D_3	79	12	D_3	79	12	D_3	79	12	D_3	79	12	D_3	79	12	D_3	79	12
A	18		A	17		B	19		B	17		C	16		C	15	
B	19		C	18		A	20		C	18		A	17		B	16	
C	20		B	19		C	21		A	19		B	18		A	17	

the rank method, when applied to the academic case here considered, fails to satisfy the following postulate, which may be regarded by many people as a fundamental principle:

Postulate of relevancy. The relative position of any two teams—or the relative position of any three teams among themselves—ought to be determinable on the basis of the actual examination-grades obtained by the members of these teams alone. In other words, in determining the relative standing of any teams among themselves, it ought not to be neecssary to take into account the performance of any contestants who do not belong to these teams.

To show that the rank method fails to satisfy this postulate, we construct the six following examples, each of which is a hypothetical, but entirely possible, case. There are four teams of three men each: "team A" has members A_1, A_2, A_3; "team B" has members B_1, B_2, B_3; and similarly for "team C" and "team D." The actual scores obtained by each of the twelve contestants, in each of the six cases I, II, III, IV, V, VI, and shown in the table; and the question is, how shall we determine the relative merits of teams A, B, C, in each of the six cases?

TABLE II

Case VII			Case VIII		
C_1	99	1	C_1	99	1
A_1	98	2			
			A_1	97	2
			B_1	95	3
B_1	94	3			
A_2	93	4			
			A_2	92	4
			D_1	91	5
			B_2	90	6
B_2	89	5			
D_1	88	6	D_2	88	7
C_2	87	7	C_2	87	8
			B_3	86	9
B_3	85	8			
D_2	84	9			
C_3	81	10	C_3	81	10
A_3	80	11			
			A_3	79	11
D_3	78	12	D_3	78	12
B	16		A	17	
A	17		B	18	

If we accept the postulate above, the relative standing of the teams A, B, C, whatever it may be, must obviously be the same in all six cases, since the actual grades obtained by the members of these teams do not vary from case to case. On the other hand, if we adopt the method of ranks, we see from the table that each of the six possible orders ABC, ACB, BAC, BCA, CAB, CBA, is represented by one of the six cases. The actual scores recorded in the six cases differ only in the scores obtained by two men, D_1 and D_2; and yet the variation in these two supposedly irrelevant items is enough to upset completely the order of merit among the three teams A, B, C.

No such ambiguity arises if the sum-of-the-grades method is employed. This method gives A 268, B 267, C 266, thus determining the order ABC.

As an even more striking illustration of the paradoxes which may result from the rank method, we construct two further examples, VII and VIII, as shown in the second table. Here there are four teams A, B, C, D, and the question raised concerns the order of the two teams A and B. In passing from case VII to case VIII every member of team B has improved his grade, while every member of team A has lowered his grade. Yet if the method of ranks is adopted, B starts out higher than A in case VII and then falls below A in case VIII. The change which has brought about this reversal of order is due entirely to changes in the grades of two men, D_1 and D_2, who do not belong to either of the teams A or B.

This paradoxical situation would not occur if the sum-of-the-grades method were used. According to this method we would have A 271 and B 268 in case VII, and B 271 and A 268 in case VIII, so that the change in the final order of merit in passing from case VII to case VIII would reflect in a natural manner the improvement in B's grade and the deterioration in A's grade.

These examples may suffice to show that if the postulate of relevancy is accepted, some method other than the method of ranks must be adopted.

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